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EXAMINER LAZORCIC, JASON L				
ART UNIT		PAPER NUMBER		
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary

Application No.

10/780,863

Applicant(s)

HONG ET AL.

Examiner

JASON L. LAZORCIK

Art Unit

1791

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 28 January 2009.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1, 2, 4 and 6-11 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1, 2, 4 and 6-11 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-8508)
- Paper No(s)/Mail Date _____

- 4) ☐ Interview Summary (PTO-413)
- Paper No(s)/Mail Date _____
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: _____

DETAILED ACTION

Status of the Claims

Applicant's reply dated January 28, 2009 adds new claims 10 and 11 and sets forth claims 1-2, 4, and 6-9 without amendment and as previously presented in the reply dated August 21, 2008.

Newly presented claim 10 recites the feature "to functionalize the carbon nanotubes" in lines 8-9

Newly presented Claim 11 is similar in scope to independent claim 1 but further limits said independent claim by reciting the phrase "consisting of" in line 6 and the phrase "consisting of" in line 9.

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 1-2, 4, 6-11 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 1 recites the limitation "the dispersion" in line 4, "the sonicated dispersion of (b)" in Line 5, "the dispersion of (c)" in line 6, and "the dispersion" in line 6. There is insufficient antecedent basis for any of the noted limitations in the claim. Further, in view of the varying references to the "dispersion", the precise metes and bounds of the

instant claim are rendered unclear and indefinite. For example, line 6 of the instant claim references "the dispersion of (c)" however step (c) above nowhere explicitly defines a dispersion of (c), and the only dispersion referenced is termed "the sonicated dispersion of (b)". More importantly, it is not evident which dispersion of the recited dispersions Applicant intends as the antecedent basis for "the dispersion" recited in line 6.

3. Similar deficiencies are noted in newly presented independent **Claims 10 and 11** with respect to the recited "dispersions" in these claims.
4. For purposes of examination "the dispersion" of Claim 1 line 6 is construed to mean the sonicated dispersion resulting from step c. Applicant is respectfully requested to clarify the claim language to provide definite antecedent basis for each "dispersion" in each of the independent claims 1, 10, and 11.
- 5.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1-2, 4, 6-7, 9, and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hwang et al. (J. Mater. Chem., 2001, 11, 1722-1725) in view of Smalley et. al. (J. Nanosci. Nanotech, 2003, V3 (1), 81-86).

As presented in the Official Action dated August 16, 2007 regarding independent **Claim 1**, the Hwang reference teaches:

1. Adding carbon nanotubes (CNTs) to an aqueous solution of cetyltrimethylammonium bromide which is read as dispersing carbon nanotubes in a dispersion medium (Pg. 1722, Column 1, Lines 38-40).
2. Sonicating the solution or "dispersion" from (1) above (Pg. 1722, Column 1, Lines 40)
3. Adding sodium silicate and sodium aluminate to the sonicated solution from (2) above which is understood as dispersing a water-soluble salt in the sonicated dispersion. (Pg. 1722, Column 1, Lines 42-44). Said sodium silicate and sodium aluminate are understood to be metal-based salts of the metals Silicon and Aluminum, respectively, and at least the sodium silicate is capable of being formed into a SiO₂ ceramic matrix prior to calcination.
4. Sonicating the solution or "dispersion" from (3) above (Pg. 1722, Column 1, Lines 44)

5. Placing the solution into an autoclave and heating at $\sim 110^{\circ}\text{C}$ to form a yellowish silicate powder followed by calcinations in air at 400°C to oxidatively remove surfactant molecules (Pg. 1722, Column 2, Lines 2-3). This disclosure is read in the immediate claim as drying and calcinating the sonicated dispersion of (4) where the water soluble salt or sodium silicate forms a ceramic matrix of SiO_2 post-calcination. Steps 1-5 yields a ceramic nanocomposite powder referred to by the authors as SiO_2 -CNT rods wherein the CNTs are homogeneously encapsulated by or "dispersed in" a SiO_2 ceramic matrix (Pg. 1724, Column 1, Lines 11-12).
6. The SiO_2 -CNT rods from (5) are mixed with SiO_2 powder and pressed into a disc followed by calcination or "further drying" in air at 400°C and calcination in an N_2 atmosphere at 1050°C to form a final composite disc.

Hwang provides concluding observations regarding the calcined salt-CNT materials and the composite ceramic material produced by mixing and hot pressing a blend of the SiO_2 -CNT material with SiO_2 powder. Specifically, Hwang discloses that "it can be deduced that the mechanical strength of the SiO_2 -CNT glass rods is stronger than the interactions between the glass rods and the matrix" (pg 1725, col.1, lines 13-28). It follows from this disclosure that the CNTs in fact do form a chemical interaction or some form of "chemical bond", be it a relatively strong covalent type bond or a relatively weak type Van Der Waals type bonding interaction, with the ceramic matrix material as presently claimed in Applicants amended claim 1.

(I) Sonication the CNT dispersion for a period between 2 to 10 hours is obvious in view of the Smalley reference

As noted above, Hwang teaches a process of forming a carbon nanotube reinforced ceramic nanocomposite. As indicated by Applicant in the reply to Office Action dated November 2, 2006, the Hwang reference teaches sonication of the CNT solution for 10 minutes but it fails to explicitly provide for an extended sonication period of between 2 and 10 hours. However, Hwang clearly indicates that a stable and homogeneous suspension is critical to the quality of the product derived from the disclosed process, and that said suspension is achieved through the sonication step.

Smalley et. al. (J. Nanosci. Nanotech, 2003, V3 (1), 81-86) teaches the relationship between sonication time and CNT dispersion in aqueous solution for time periods up to approximately 5 hours. With specific attention to the instant reference Figure 2, Smalley tracks the intensity of a spectral feature indicative of dispersion quality as a function of time under continual sonication. The reference teaches that dispersion quality increases at least through the first four hours of sonication. It is the Examiners position that optimization of the sonication time was a recognized result effective variable of the dispersion quality at the time of the invention and that said time period would have been optimized through routine experimentation by one of ordinary skill in the art.

More specifically, it would have been obvious to one of ordinary skill in the art at the time of the invention to sonicate the CNT dispersion for a time period up to at least 5 hours in an effort to provide a high quality dispersion of CNTs. A high quality dispersion would have been a routine goal for one of ordinary skill seeking to optimize the uniformity of the resultant ceramic composite, and a sonication period between 2 to 10 hours is a minor and obvious extension over the prior art.

(II) The Hwang Disclosed Dispersion Reads Upon the Composition of Applicants
Claimed Dispersion "Consisting Essentially Of" the Named Components

Applicant claims (see claim 1, lines 6-7) require that the water soluble salt "includes" metal-based salts capable of being formed into a ceramic matrix. Where the water soluble salt is claimed to broadly "include" a metal-based salt, said water soluble salt is not construed to be exclusive of additional and unnamed components.

Although the transitional phrase "consisting essentially of" is construed to limit the scope of a claim to the specified materials or steps "and those that do not materially affect the basic and novel characteristic(s)" of the claimed invention, *In re Herz*, 537 F.2d 549, 551-52, 190 USPQ 461, 463 (CCPA 1976), the composition of the "water soluble salt" is itself not construed to be particularly limited. Further, Applicant has failed to clearly delineate the basic and novel characteristics such that one may reasonably ascertain what materials are excluded from the claimed dispersion. In view of the foregoing, Applicants claimed dispersion composition of claim 1 is construed as equivalent to a fully open claim drafted in a "comprising" format.

Applicant was previously advised that Hwang teaches preparing a dispersion comprising carbon nanotubes, a water-soluble salt capable of being formed into a ceramic matrix (e.g. sodium silicate and/or sodium aluminate), a water soluble quaternary ammonium salt (e.g. C₁₆TAB bromide) or surfactant, and water. Where Applicants claimed water soluble salt is not construed to exclude additional components, including *inter alia*, a water soluble quaternary ammonium salt or surfactant, the Prior Art dispersion is understood to read directly upon Applicants claimed dispersion "consisting essentially of" the named components. That is, the Examiner can construe no reason to suggest that incorporation of the C₁₆TAB surfactant or quaternary ammonium salt as a component of the water soluble salt "including" the named metal-based salt would in any manner violate the basic and novel characteristics of the claimed invention or that the C₁₆TAB component should otherwise be excluded from the claimed dispersion composition.

Further, Applicant is advised that the quaternary ammonium salt is present only in a trace concentration level, namely at a 1.2 milli-molar concentration as recognized by Applicant on page 6, §A of the instant reply. To put this matter into perspective, even if the C₁₆TAB were to be construed as a component of the dispersion medium for the sake of argument, which the Examiner does not necessarily consider to be the case, the dispersion medium would still consist of 99.88% water on a molar basis. Here again, the quaternary ammonium salt is present at trace levels which absent

compelling evidence to the contrary do not violate the basic and novel characteristics of the claimed invention.

Although it has been reasonably demonstrated above that the prior art dispersion properly reads upon applicants recited dispersion composition, Applicant is additionally cautioned that claims drafted in "consisting essentially of" terms will be construed as equivalent to "comprising", absent a clear indication in the specification or claims of what the basic and novel characteristics actually are; See, e.g., PPG, 156 F.3d at 1355, 48 USPQ2d at 1355. As noted in MPEP §2105, Applicant has the burden of showing that the introduction of additional steps or components would materially change the characteristics of applicant's invention. In re De Lajarte, 337 F.2d 870, 143 USPQ 256 (CCPA 1964). See also Ex parte Hoffman, 12 USPQ2d 1061, 1063-64 (Bd. Pat. App. & Inter. 1989).

The Specification as originally filed fails to provide any basis to conclude that addition of a quarternary ammonium salt at the millimolar concentration level would violate the basic and novel characteristics of the claimed invention. Further, Applicant has to date failed to provide any evidence on the record to support this assertion.

Claim 2 is obvious in the rejection of Claim 1 above wherein it was set forth that the CNT dispersion is an aqueous solution.

Claim 4 is obvious in light of the rejection of Claim 1 wherein a ceramic matrix of SiO₂ is from the group including silicon oxides.

Claim 6 is obvious in light of the rejection of Claim 1 above wherein the claimed drying temperature range of 80 to 100°C is understood to be encompassed by ~110°C or “approximately” 110°C.

Alternately if it is deemed that “approximately” 110°C fails to read upon the disclosed temperature range, it would be obvious to one of ordinary skill in the art, seeking to dry a dispersion, to perform said drying step within a temperature range suitable for evaporating the dispersion medium. In the immediate case wherein said dispersant is water with a normal boiling point of 100°C, drying said dispersant at approximately 110°C would obviously encompass drying the dispersant in the temperature range of 80°C to 100°C since the latter range would yield materially equivalent drying effect.

Regarding **Claim 7**, Hwang indicates that “the silicate powder” described in the rejection of Claim 1 above is calcined in air at 400°C to oxidatively remove surfactant molecules. Although the instant reference does not explicitly teach the calcinations in the temperature range of 300 to 350°C as claimed, it is the examiners position that one of ordinary skill in the art at the time of the invention would be fully capable of determining the appropriate calcination temperature for a given ceramic matrix material.

While the Examiner acknowledges that the prior art range does not explicitly overlap the claimed range, the prior art calcining temperature of 400°C would be recognized by one of ordinary skill as so near the prior art temperature range as to be patentably indistinct therefrom. More specifically, one of ordinary skill in the art would have found ample motivation to explore lower calcining temperatures in an effort to

reduce processing costs associated with manufacturing the ceramic composite material. Therefore absent any compelling and unexpected results showing to the contrary, claimed calcining temperature range of 300-350°C is held as a merely obvious extension over the prior art teachings.

With respect to **Claim 9**, the claim requires a calcinations temperature of 400oC or lower. Hwang indicates that "the silicate powder" described in the rejection of Claim 1 above is calcined in air at 400°C to oxidatively remove surfactant molecules. As such the Hwang process reads on the broad limitation of the claim which requires a calcination temperature of 400°C or lower. Further, where no distinction is drawn between the process of drying and the process of calcination, it is understood that the act of heating the silicate powder to the calcination temperature inherently requires traversing the claimed temperature range of 300 to 350oC. Since the primary solvent utilized by Hwang is water as indicated above, with a normal boiling point of 100oC, the act of heating the silicate powder through the temperature range of 300 to 350oC is understood to "further dry" said ceramic matrix.

Regarding newly presented independent **Claim 10**, Applicant recites the new limitation wherein the dispersion is sonicated "to functionalize the carbon nanotubes" in line 9. The remainder of the claim is identical in scope to independent claim 1 as discussed above.

With respect to this new limitation, Applicant was previously advised that Hwang discloses adding carbon nanotubes (CNTs) to a 99.88 mol% aqueous solution of

cetyltrimethylammonium bromide (Pg. 1722, Column 1, Lines 38-40). Regarding the recited functionalization of the carbon nanotubes, Applicants own Specification (see ¶[0020]) states that,

"Examples of the dispersion medium for dispersing the carbon nanotubes include, but are not limited to, water, ethanol, nitric acid solution, toluene, N,N-dimethylformamide, dichlorocarbene, thionyl chloride, etc. Water, ethanol and nitric acid solution have simple properties and excellent dispersibility due to formation of electrostatic charges and carboxylation on the surface of the carbon nanotubes".

It would appear evident in view of Applicants foregoing admission and absent compelling evidence to the contrary, that sonication of the carbon nanotubes in the aqueous solvent according to the combined teachings of Hwang and Smalley would inherently result in the recited "functionalization" of the CNT surface.

Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hwang (J. Mater. Chem., 2001, 11, 1722-1725) and Smalley et. al. (J. Nanosci. Nanotech, 2003, V3 (1), 81-86) as applied to Claim 1 above and in further view of Chang (6,420,293).

Hwang teaches that the SiO₂-CNT powder is to be calcinated in an N₂ atmosphere at 1050°C which falls within the claimed temperature range of 400-1700°C. Hwang fails

to explicitly set forth that the calcination of the ceramic matrix, requiring a calcination temperature of 400°C or higher as indicated above, should be performed under a high vacuum as claimed. Chang teaches that "heating of carbon nanotube materials at elevated temperatures in an oxidizing environment typically results in chemical changes in the surface of the particles (Column 3, Lines 51-54) and specifically that "heating in air at 640°C results in the formation of carboxyl and carbonyl groups at the particle surface" (Column 3, Lines 57-59). Both the N₂ atmosphere and a high vacuum environment are commonly utilized and well appreciated in the art as non-oxidizing environments. Processing under a high vacuum would be an obvious alternative for the nitrogen atmosphere since the Hwang process utilizes calcination temperatures of 1050°C and damage to the CNTs occurs at temperatures in excess of 640°C under oxidative environments as indicated by Chang. Therefore it would be obvious to one of ordinary skill in the art seeking to minimize said oxidative damage to substitute a high vacuum environment for the nitrogen atmosphere in the Hwang process since both nitrogen and high vacuum provide the requisite non-oxidative environments.

Allowable Subject Matter

6. Claim 11 would be allowable if rewritten or amended to overcome the rejection(s) under 35 U.S.C. 112, 2nd paragraph, set forth in this Office action.
1. The following is a statement of reasons for the indication of allowable subject matter in Claim 11: As noted in the rejection of claims above, both Hwang and Smalley incorporate a water soluble salt (e.g. C₁₆TAB bromide) or surfactant in the dispersion.

Therefore, the prior art of record does not teach nor fairly suggest the recited step of sonicating a dispersion "consisting of the carbon nanotubes, the water soluble salt, and the dispersion medium, wherein the dispersion medium is selected from the group consisting of water, ethanol, nitric acid solution, toluene, N,N-dimethylformamide, dichlorocarbene, and thinly chloride" as recited in claim 11, lines 8-12 and wherein the water soluble salt "consists of metal-based salts capable of being formed into a ceramic matrix post calcination" as recited in Claim 11, Lines 6-7.

Response to Arguments

Argument 1)

Applicant alleges that Hwang does not disclose the dispersion medium as recited in claim 1. Specifically, Applicant alleges that since Hwang employs a 1.2mM solution of C16TAB then the prior art fails to teach a dispersion medium "consisting essentially of" the named components.

Applicants arguments on this matter have been previously addressed in the Official Action dated October 28, 2008 (see page 11).

Specifically, Applicant was advised that claims drafted in "consisting essentially of" terms will be construed as equivalent to "comprising", absent a clear indication in the specification or claims of what the basic and novel characteristics actually are; See, e.g., PPG, 156 F.3d at 1355, 48 USPQ2d at 1355. As noted in MPEP §2105, Applicant has the burden of showing that the introduction of additional steps or components would materially change the characteristics of applicant's invention. In re De Lajarte, 337 F.2d

870, 143 USPQ 256 (CCPA 1964). See also *Ex parte Hoffman*, 12 USPQ2d 1061, 1063-64 (Bd. Pat. App. & Inter. 1989). With respect to this matter, the addition of C16TAB is nowhere explicitly excluded in the originally filed Specification and Applicant has failed to present any convincing evidence to suggest that incorporation of the C16TAB in a molar concentration of 0.12% materially alters the basic and novel characteristics of the recited invention.

Further, the C16TAB may reasonably be construed as an additive and not as alleged by applicant as a dispersion medium.

Applicant next argues that "the addition of detergent to the dispersion would materially affect the basic and novel characteristics of the invention. Applicant alleges that incorporation of surfactant to the dispersion medium would "reduce the formation of chemical bonds between the functionalized carbon nanotubes and the water-soluble salts.

Applicants arguments on this matter are acknowledged by the Examiner but are deemed unpersuasive absent compelling evidence on the record in support of said allegations. First, the Specification as originally filed has failed to clearly delineate the basic and novel characteristics such that one may reasonably ascertain what materials are excluded from the claimed dispersion. Second, Applicant has provided no conclusive evidence in support of the allegation that addition of a surfactant at a 0.15 mol% concentration materially affects formation of bonds between the CNT and the

water soluble salt, it follows that said allegations are held to be mere conjecture and attorney argument.

The Official policy regarding Attorney argument is clearly outlined in MPEP §2145 [R-3];

"Attorney argument is not evidence unless it is an admission, in which case, an examiner may use the admission in making a rejection. See MPEP § 2129 and § 2144.03 for a discussion of admissions as prior art. The arguments of counsel cannot take the place of evidence in the record. In re Schulze, 346 F.2d 600, 602, 145 USPQ 716, 718 (CCPA 1965); In re Geisler, 116 F.3d 1465, 43 USPQ2d 1362 (Fed. Cir. 1997) ("An assertion of what seems to follow from common experience is just attorney argument and not the kind of factual evidence that is required to rebut a prima facie case of obviousness."). See MPEP § 716.01(c) for examples of attorney statements which are not evidence and which must be supported by an appropriate affidavit or declaration.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JASON L. LAZORCIK whose telephone number is (571)272-2217. The examiner can normally be reached on Monday through Friday 8:30 am to 5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Steven Griffin can be reached on (571) 272-1189. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/ Carlos Lopez/
Primary Examiner, Art Unit 1791
/J. L. L./
Examiner, Art Unit 1791